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It is that Dreaded Error Report: An Empirical Assessment of Error Reporting Behavior

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ABSTRACT

Software companies are currently using the Internet to solicit information from users about errors in the applications and using this information to prioritize further development efforts. To increase the likelihood of error reporting by users, it is important to systematically understand user perceptions that drive their intention to use an error reporting system (ERS). We theorize that perceived expected benefits of using ERS, the user's value system, and design elements of the ERS are factors that drive ERS usage intentions. The results show that the users find ERS useful, if they believe that ERS is congruent with their values and will benefit them in future. While clarity of role and process transparency were identified as important factors, the ability to examine information transmitted through the ERS was not found to influence ERS usefulness. Prescriptive guidelines on effective design of the ERS and discussion on avenues of future research are offered.

Keywords

Technology acceptance model, error reporting system, user beliefs, user acceptance, user involvements

INTRODUCTION

User involvement in the software development process is an important area in IS research. Past research in this domain focused on examining the positive effects of involvement on information system (IS) success and IS acceptance (Baroudi, Olson, and Ives, 1986). Consequently, conditions that enhance user involvement have also been examined. However, most of these studies examined traditional software development contexts in which software upgrades took longer and were introduced through release of new versions of the software application. The emergence of the Internet has profoundly impacted the software development process. Specifically, in the context of commercial software, firms regularly develop and offer patches to remove vulnerabilities, fix bugs, and add new features. In addition to using the Internet as a delivery mechanism for upgrades and updates, software firms are also soliciting inputs on errors and bugs from users while they are using the application. The error report that pops up every time the software application hits a bug is an example of this approach. Limited knowledge, however, exists on why users respond to such systems. This study intends to investigate this issue.

LITERATURE REVIEW

Technology acceptance model, theory of planned behavior, and innovation diffusion theory are the dominant theoretic perspectives that have been used to examine IS acceptance and usage intentions (Davis, 1989; Ajzen, 1991, Rogers, 1995). Using an ERS is however different than using other information systems because the usage does not directly facilitate user's work or increase their job performance, the users do not control the information that is transmitted through ERS, and usage of ERS is completely voluntary. This novel context needs to be explicitly considered in the use of theoretical perspectives and factors that could influence user's error reporting behavior. We draw on theories on IS usage, literature on customer involvement in new product development, and literature on donation behavior to development the research model. Our analysis of these literature streams within the context of ERS usage is presented in the subsequent section.

Venkatesh and Davis (2000) argue that user actions with regards to information systems are based on cognitive instrumental processes. Cognitive processes relate to an assessment of the fit between the user's goals and his/her perceptions regarding how well IS could enable them to achieve those goals. Goals may be based on utility motives and/or a selfless response to a solicitation that a person perceives as appropriate. Goal attainment may also be impacted by the design elements of the solicitation system.

Utility theory argues that human actions are driven by the motives of maximizing personal benefit. Decisions are based on a comparison between the benefits that will accrue against the costs that will be incurred. Perceived consequences are highlighted by research on theory of reasoned action as an important driver of why certain actions are taken (Limayem, Khalifa, and Frini, 2000). Researchers argue that, in addition to utility maximization, users also have behavioral inclinations that provide insights into their actions (Howard and Seth, 1969). One aspect that has been consistently found to influence usage of technology at the individual level is compatibility. Rogers (1995) defines compatibility as the extent to which the potential adopter perceives that using an innovation is consistent with the socio-cultural norms, past and present experiences, and their specific needs. Individuals develop and adhere to a value system, which plays a pivotal role in influencing their actions (Douglas

et al. 2001). Software applications are modeled around activity models that provide specific approaches towards task completion. Value compatibility captures the alignment of the task approach supported by the software application and the overall value system of the user.

In addition to expected benefits and value compatibility, user perceptions toward the design elements of the ERS could also play a pivotal role in influencing their usage intentions. Nasmbisan (2002) proposes that transparency regarding the role that the individuals are performing and how their inputs will be processed induces greater contributions to new product development process. Sending an error report could be viewed as a free service that users perform and thus depicts similarity to donation behaviors. Prior research on examining the impact of donation solicitation suggests that content of solicitation that explicitly elaborates on the role of the donor and how the donation will be used could enhance the intent to donate (LaTour and Manrai, 1989; Radley and Kennedy, 1995). Informing the donors about actual programs that benefit or have benefited from the donations could also increase the likelihood of donation.

The ERS extracts information from the user's computers and transmits that information over the Internet. It is therefore important that the users comprehend the role they are assuming when interacting with the ERS, what information is being extracted from their computer, and how that information will be processed. Transparency indicates openness that is gained through communication and exchange of information regarding roles, expectations, and visibility of the internal mechanisms of the processes that are involved (Nasmbisan, 2002). At a more granular level, role transparency, process transparency, and data transparency are three distinct factors that are important.

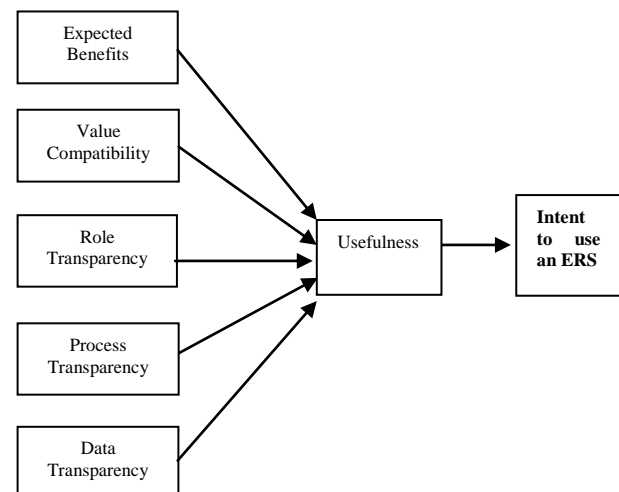
Review of literature reveals important factors such as expected benefits, value compatibility, and transparency that could influence ERS usage intentions. These factors emerge from various theoretical perspectives that elaborate on why customers/users take certain actions in a given context. We believe that following theoretical pluralism contributes towards identifying a broader set of factors that could influence ERS usage behavior. Next, we elaborate on the research model.

RESEARCH MODEL

TAM has been used to predict usage intentions in the context of information systems that are likely to enhance user performance as well as those that provide hedonic benefits. However, its applicability on systems that have minimal immediate benefits to the users has not been sufficiently examined. We argue that TAM is the appropriate theoretical lens to examine ERS usage. The objective behind reporting errors is to further improve the software application. ERS provides the users with an avenue to achieve this objective. Thus, ERS is similar to a task centric system that provides the users with

opportunities to report errors (undertake a task). Task completion (reporting errors) may be driven by altruistic or hedonic motivations. Although, immediate benefits to the users may not exist, the users could still assess the ERS as a mechanism that enables them to better contribute to the software development. Based on this presumption, it can be argued the user's perceptions regarding how well the ERS supports the error reporting process is likely to influence their usage intentions.

FIGURE 1: RESEARCH MODEL



TAM further argues that the impacts of exogenous factors on intention are mediated through the user's perception regarding usefulness of the IS (Venkatesh and Davis, 2000). Thus, we theorize that the impact of perceived expect benefits, value compatibility, and transparency on the intention to use ERS will be mediated by perceived usefulness of the ERS (see Figure 1). The subsequent section elaborates on our proposed hypotheses.

HYPOTHESES

Expected Benefits

Expected benefits, in this study, are defined as the extent to which using an ERS will ensure that future version of the software application will be of higher quality. Thus, expected benefits capture the future expectancy of the current contribution of the user (Chewlos et al., 2001). Although differences exist between individuals regarding their disposition towards the immediacy and tangibility of the benefits, they expect from taking certain actions. Past stream of research has indicated that individuals are willing to participate in activities that may yield long-term benefits (Chau 1996). If the users believe that reporting errors will in turn provide them with a better quality software application, it will strengthen their perception regarding the efficacy of the ERS as a method to contribute to the application development process.

H-1: Expected benefits is positively associated with usefulness of ERS

Value Compatibility

Personal values are beliefs that certain modes of action are preferable (Douglas et al. 2001). An individual's value system consists of a set of standards. Actions that comply with these standards are deemed to be appropriate (Forsyth, 1992). Standards are abstract, acquired over time, and influenced by a multitude of factors ranging from parental guidance to social norms. Individuals who conform to standards are termed as idealist in contrast to relativists who approach issues from multiple perspectives and do not adhere to a specific ethical standard. When confronted with a decision, individuals can conform to idealistic or relativistic approaches, and later construct the basis of their actions based on a value system. This value system will either justify the action based on situational factors or moral rules. The value system of an individual could in turn prescribe the approach that is accepted as the "right approach". Value compatibility, in this study, is defined as the extent to which the ERS is perceived as an appropriate method for soliciting information on errors.

Individuals may view information systems as a mean to an end and thus an enabler for achieving certain objectives (i.e. improvement in software that will be beneficial to anyone who uses it). If the ERS offers an approach that is considered by the users to provide an appropriate approach in achieving those objectives, it could alter their perceptions regarding the value of the ERS. Thus we argue:

H-2: Value compatibility is positively associated with usefulness of ERS

Transparency

Users, when facing with the decision to send an ERS, may take into consideration what type of role they are assuming, what information is extracted from their computer for transmission, and how this information will be processed. We refer to these as role, data, and process transparency respectively. We define role transparency as the extent to which the user clearly understand his/her position while sending an error report. Process transparency captures the extent to which the user clearly understand how the information transmitted through the ERS will be processed (more specifically who will be receiving the information, who will have access to this information, and how it will be stored). Data transparency is defined as the extent to which the user can view and examine the information that will be transmitted through the ERS.

In marketing literature, Nasmbisan (2002) argues that transparency between the customers and product development team enhances the likelihood of their contributions to new product development. In addition, literature on donations proposes that when a person is presented with a decision regarding donation, their initial reaction is not to donate (LaTour and Manrai, 1989). Ambiguity regarding the impact and processing of the donation is a likely reason for this disposition. Transparency creates a situation wherein, the users are

informed about the role they assume while electing to use the ERS, understand how their inputs will be processed, and have the ability to examine and view the information being transmitted. Openness regarding these issues surrounding the ERS is likely to alleviate user's concerns. Role, process, and data transparency could thus positively influence the user's disposition towards the ERS as an effective means to contribute towards the further development of the software application. Hence, we propose;

H-3: Role transparency is positively associated with ERS usefulness

H-4: Process transparency is positively associated with ERS usefulness

H-5: Data transparency is positively associated with ERS usefulness

Usefulness

Users would be more inclined to use the ERS if they perceive that it enhances their performance in contributing to the development of the software application (Davis, 1989). Users are members of a community that assist in improving the quality of the software application, in the post release phase. ERS provides an efficient and effective mechanism for them to contribute to this process. Thus we argue:

H-6: Usefulness of ERS is positively associated with intention of use ERS

RESEARCH METHOD

Our study adopted survey as its underlying methodology. The items for usefulness and intention to use were adapted from previous research (Davis, 1989, Venkatesh et al. 2003). New scales were developed and validated for measuring value compatibility, role transparency, process transparency, data transparency, and expected benefits (items available upon request). The development of the new scales was conducted in three steps. At the first step, a thorough review of literature was undertaken for comprehending the conceptual structure of the constructs and subsequent item creation.

The second step involved two pilot tests, the first with a relatively small samples ($n=20$) and the second with a relatively larger samples (70). In both pilots, the subjects were informed about the objectives of the study. We provided the subjects with a picture of the error report and brief description of the project. The subjects were then asked to complete the questionnaire. The instrument was revised based on the suggestion provided by the subjects. The final step involved conducting the survey with a larger sample ($n = 274$). However, due to missing values and partially filled questionnaires, the sample size dropped to 258. Further, 25 respondents did not have any exposure to an error reporting system, so their responses were deemed unusable reducing the sample size to 233. This sample was combined with data collected from the

second pilot study because the current instrument was a subset of the earlier one, providing a total sample size of 303. Subjects were students enrolled in executive MBA, graduate, and undergraduate classes in the business school at two universities. The respondents had extensive experience in using computers (11 years by average) and the Internet (8 years by average). They also seem to be spending considerable time on computers (28 hours per week by average) and the Internet (15 hours per week by average). The most cited application that generated the error report was Internet explorer, followed by Microsoft Office and Windows operating system. Other applications such as Netscape and real player were also reported.

CONSTRUCT VALIDITY AND RELIABILITY

Exploratory and later confirmatory factor analyses were used to assess construct validity (Agarwal and Prasad, 1998). Exploratory factor analysis with principal components extraction and varimax rotation was used in the pilot studies for scale refinement. A six-factor solution was obtained and loadings ranged from 0.74 to 0.94. CALIS procedure in SAS was used for confirmatory factor analysis to further assess the measurement properties of the constructs in the model. The ratio of Chi sq over degrees of freedom was 2.63, which is within the recommended range (Sharma, 1996). Other fits indices such as RMSEA (0.07), NFI (0.93) and CFI (0.96) also met the recommended guidelines providing support for the hypothesized structure of the latent constructs.

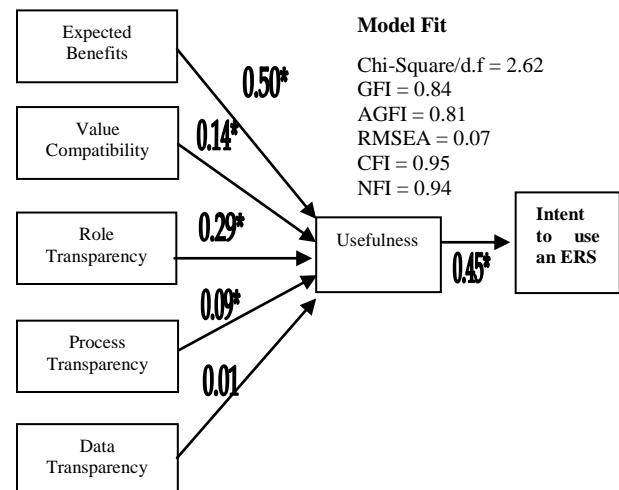
Additionally, convergent validity was examined through composite reliability (internal consistency) and Cronbach's alpha. The values for these assessments were above the recommended guideline of 0.70 (Sharma, 1996). The analysis also provided evidence for discriminant validity as in all cases the average variance extracted (AVE) (diagonal values are AVEs) for individual construct was greater than the squared multiple correlations of that construct with other constructs (Fornell and Lacker, 1981). Analysis for the psychometric properties of the scales shows that they depict good measurement properties.

RESULTS

The results of the structural model show that the data adequately fits the model. The fit statistics such as the ratio between Chi Square and degree of freedom is below 3. NFI, RMSEA, and CFI are also above the recommended guidelines (See Figure 2). The significance of the individual paths provides the results for the hypotheses. Expected benefits and usefulness demonstrate a significant positive relationship supporting H-1. Value compatibility was found to positively influence usefulness of ERS (H-2). However, the results for the relationship between transparency and usefulness of ERS were mixed. It was found that role and process transparency positively effect usefulness of the ERS, supporting H-3 and H-4. No significant relationship between data transparency and usefulness was observed. Thus, H-5 was not supported.

Finally, the results confirm the hypothesized positive relationship between usefulness and user's intention (H6).

Figure 2: Results of the Structural Model



DISCUSSION

We draw on extant literature to develop a research model that examines user behavior with the ERS. We found that users who perceive the ERS as useful have expectation that it will pay off in the long run. Users find ERS useful if they deem it to be an appropriate mechanism for error reporting. User's clarity about the role and understanding of where the information will be transmitted and how it will be processed also significantly impact their perception of ERS usefulness. However, visibility of and access to data transmitted through ERS did not alter their beliefs about the value of ERS. Finally, intention to use ERS was influenced by ERS usefulness.

In the survey the subjects were also asked to provide contextual insights by inviting them to state the most important factors that may induce them to send error reports more frequently. After a thorough review of the qualitative responses, we segmented them into five categories namely frequency (30%), fix assurance (22%), time constraint (15%), feedback (8%), and data and process clarity (5%). Only 1% of the respondents reported that they would increase the use of ERS if the soliciting firm provided an incentive.

The results of the study and the contextual insights provide avenues for future research. We believe that the role of feedback, data transparency, time constraint, and incentives in enhancing the use of ERS requires in-depth examination. The design elements of the ERS also merit further investigations. An interesting approach in this regard would be to examine the effectiveness of using an aggregation approach wherein error reports are accumulated over time and then sent as one package at periodic intervals. We also believe that the results of the study provide good prescriptive implications for ERS promotion and design. Users recognize the benefits of using the ERS, but at the same time, are concerned about

the actual value of their inputs. Better promotion and feedback that elaborates on the actual improvements made to the application based on the information collected through the ERS can potentially influence user behavior. Another approach can be to link the software updates provided through the Internet with errors reported through the ERS. We believe that such an approach will not only reinforce the user's beliefs about expected benefits but also alleviate concerns about actual usage of information reported through ERS. These suggestions can help the developers of ERS to configure the ERS design such that it increases the likelihood of its usage.

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